

DOES AIR WEIGH ANYTHING?¹

Grade Levels: 4-6

Time: 40-50 minutes

Purpose

To demonstrate that air has weight.

The lesson is important for building a foundation for other lessons regarding matter and its fundamental units, air and its properties, and air pollution concepts. The lesson also helps students begin developing observation and prediction skills.

Background

Air is not empty space. It is made of matter – mainly different types of gases. The normal composition of air is about 78% nitrogen (N₂), 21% oxygen (O₂), and 1% other gases such as argon (Ar), carbon dioxide (CO₂), methane (CH₄), and helium (He). The gases are comprised of molecules that are made up of atoms, the fundamental units of matter. Some gases are just made up of atoms. Air is essentially a layer of trillions and trillions of gas molecules.

Air also contains solid particles (e.g., dust, ash, etc.), water droplets, and ice crystals. These materials are also comprised of molecules that are made up of atoms. However, these materials are not considered part of the normal composition of air. Nevertheless, collectively, air is made up of matter such as gases, solid particles, water droplets, and ice crystals. All matter occupies space and has weight.

Objectives

Students will:

1. List five materials present in air that help give it weight.
2. Predict the result of placing three air-filled balloons on one side of a balance and placing one air-filled and two empty balloons on the opposite side of the balance.
3. Draw a picture of the outcome of Objective #2.
4. Explain the outcome of Objective #2.

¹ Adapted from Air and Waste Management Association, Environmental Resource Guide-Air Quality, Grades 3-5, "Here, There, and Everywhere" Activity, Pg. 29-46, 1996.

Materials

- 2 standard height tables
- 4 “archive” or similar boxes (10-15 inches high)
- Yardstick
- 18 inch stick (or half of a yardstick)
- 20 inch piece of string
- 2 pieces of string (each 12 inches long)
- Masking tape
- 7 balloons (minimum size: 12 inch “helium quality”)
- Scissors
- Chalkboard and chalk
- 7 non-breakable objects of varying weight (e.g., pen, pencil, eraser, sponge, etc.)
- Worksheet – Does Air Weigh Anything? (included)

Activity

1. Have students drop the non-breakable objects on the ground several times. Ask students why the objects fall to the ground. (*Each object has weight.*)
2. Have students stand and jump up as high as they can. Have students perform this activity several times. Ask students why they fall back to the ground. (*Each student has weight.*)
3. Give a student an empty balloon and have him/her drop it on the ground several times. Ask students why the empty balloon falls to the ground. (*The empty balloon has weight.*)
4. Give the student another balloon and have him/her inflate it and then drop it on the ground several times. Have the student hold the empty balloon in one hand and the inflated balloon in the other hand. Ask students: Is the inflated balloon heavier than the empty balloon? (*Yes, no.*) Who thinks the inflated balloon is heavier than the empty balloon? (*Some students will raise their hands.*)
5. Explain that this question can be tested with the use of a balance that is set up similar to a teeter-totter.
6. Have students perform as many of the steps below as possible.

7. Using the tables, boxes, yardstick, 20-inch string, and 18-inch stick, set up a balance similar to that shown in Diagram 1 below. Use masking tape to secure the yardstick to the boxes and to keep the yardstick and 18-inch stick from sliding through the string.

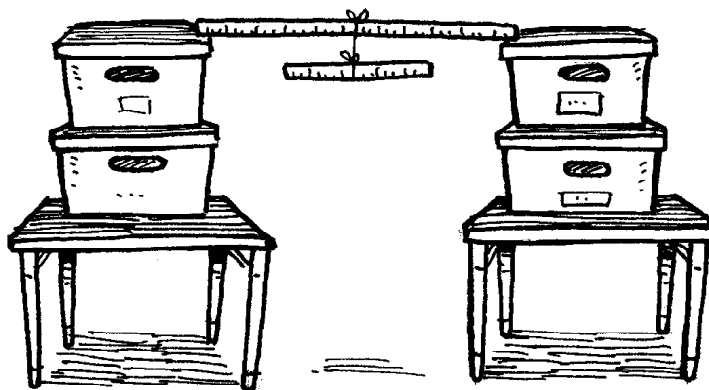


Diagram 1

8. Blow up four balloons to as close an equal volume as possible.
9. Tie each 12-inch string to each of two inflated balloons.
10. Tie the open end of each 12-inch string to each end of the 18-inch stick ensuring that the inflated balloons balance each other. If necessary, tape the string to the 18-inch stick to keep it from sliding.
11. Explain that at this point the 18-inch stick is balanced by the weight of each inflated balloon.
12. Hand out the “Does Air Weigh Anything?” Worksheet. Ask students to predict what will happen if an inflated balloon is attached to the inflated balloon on the left side of the balance and an empty balloon is attached to the inflated balloon on the right side of the balance. Ask students to write their prediction in section #1 on their worksheet.
13. Ask students what they predicted. *(The left side with the two inflated balloons will drop lower, remain the same, or rise higher than the right side with the inflated and empty balloons.)*
14. Stick a piece of masking tape (tape should be rolled up so that the ends overlap creating a double-sided tape) to an inflated balloon and stick it onto the inflated balloon on the left side of the balance.
15. Stick a rolled up piece of masking tape to an empty (deflated) balloon and stick it onto the inflated balloon on the right side of the balance. There are now two inflated balloons on the left side of the balance, and one inflated and one empty balloon on the right side of the balance.

16. Ask students what happened after the inflated and deflated balloons were added, and to write their answers in section #2 on their worksheet. *(The left side with the two inflated balloons dropped lower than the right side with the inflated and deflated balloons.)*
17. Ask students why the left side dropped lower. *(The left side with two inflated balloons has more air, which makes it heavier than the right side with the inflated and empty balloons.)*
18. Ask students to silently predict what will happen if a third inflated balloon is added to the left side of the balance and a second empty balloon is added to the right side of the balance.
19. Stick a piece of masking tape (tape should be rolled up so that the ends overlap creating a double-sided tape) to an inflated balloon and stick it onto the inflated balloon on the left side of the balance.
20. Stick a rolled up piece of masking tape to an empty (deflated) balloon and stick it onto the inflated balloon on the right side of the balance. There are now three inflated balloons on the left side of the balance, and one inflated and two empty balloons on the right side of the balance. The final setup is shown in Diagram 2 below.

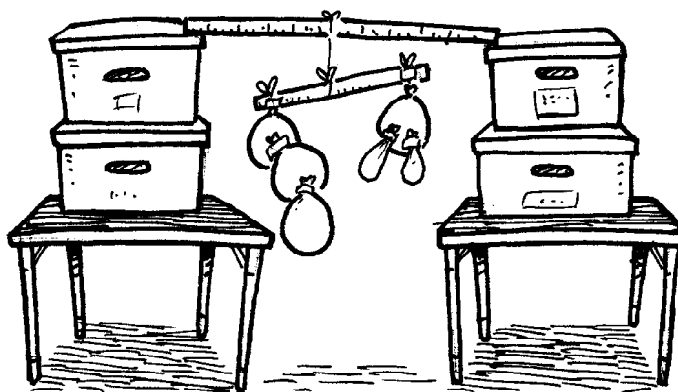


Diagram 2

21. Ask students what happened after the second inflated balloon was added to the left side and a second empty balloon was added to the right side. *(The left side dropped even lower than the right side.)*
22. Ask students why the left side dropped even lower. *(Since air has weight, the combined weight of three inflated balloons on the left side is heavier than the combined weight of one inflated and two empty balloons on the right side.)* Have students make a drawing of the final position of the balance and balloons in section #3 on their worksheet.

23. Ask students why air has weight. (*Air is made up of different materials, or matter, that have weight.*) Ask individual students to write on the chalkboard the names of different materials that make up air and have weight. (*Possible answers are gases such as nitrogen, oxygen, carbon dioxide, argon, methane, helium, and hydrogen; solid particles such as smoke, ash, dust, and soot; water vapor; and ice crystals.*)
24. Ask students what makes up the materials, or matter, that give it weight. (*The materials, or matter, are made up of very small units called atoms. Each atom occupies space and has weight. Some matter is made up of atoms. Most matter is made up of molecules, which are made up of atoms.*)
25. Have students complete section #4 on their worksheet.

Student Understanding and Reflection

1. Discuss questions on the worksheet and solicit student responses.
2. Have students reflect on their learning:
 - (a) I was surprised to learn that air...
 - (b) How has my idea about air changed?
 - (c) Some types of materials present in air are...
 - (d) Air has weight because...
 - (e) I am interested in learning more about...

Wrap Up

Explain that the balloons and balance demonstrated that air has weight (and occupies space) because the side of the balance with more air-filled balloons dropped lower than the side with more empty balloons. Explain that air is not empty space, but is made of gases such as nitrogen, oxygen, argon, carbon dioxide, methane, and helium; solid particles such as dust, smoke, and ash; water droplets; ice crystals; and many other materials. These materials, or matter, are composed of very small units called atoms. All matter occupies space and has weight.

California Science Content Standards, K-12 (Adopted 1998)

Concepts of the lesson may be connected to the grade-specific content standards below:

Grade Four

- 6c. Formulate and justify predictions based on cause-and-effect relationships.

Grade Five

- 1b. Students know all matter is made of atoms, which may combine to form molecules.
- 6b. Develop a testable question.

Grade Six

- 7e. Recognize whether evidence is consistent with a proposed explanation.

Worksheet: Does Air Weigh Anything?

Name _____ Date _____

1. Predict what would happen if an inflated balloon is added to the inflated balloon on the left side of the balance and an empty balloon is added to the inflated balloon on the right side of the balance.

2. Was your prediction correct? _____. If not, what actually happened?

3. Make a drawing of the position of the balance and balloons.

4. Write the names of five materials that are present in air.
 - (a) _____.
 - (b) _____.
 - (c) _____.
 - (d) _____.
 - (e) _____.